ADVANCES IN THE DEEP SPACE NETWORK – ADDING KA-BAND TO THE 70-METER ANTENNA

William A. Imbriale and Daniel J. Hoppe
California Institute of Technology
Jet Propulsion Laboratory
Pasadena, CA 91109

With the advent of faster, cheaper planetary missions, the coming decade promises a significant growth in the number of missions that will be simultaneously supported by NASA's Deep Space Network (DSN). Ambitious outer planet missions, with extremely tenuous communications links due to their great distances, and data-intensive orbiter or in situ missions incorporating high-bandwidth science instruments will demand improved telecommunications capabilities. The Telecommunications and Mission Operations Directorate (TMOD) at the Jet Propulsion Laboratory, which operates NASA's Deep Space Network, has developed a road map for deep-space telecommunications through the year 2010 that meets these challenges. One key aspect of this road map is the rapid infusion of Ka-band (32-GHz) into the DSN and into future spacecraft.

The gain performance of the 70-meter antenna at Ka-band falls off rapidly as the antenna is pointed at targets either above or below the elevation angle for which the antenna was optimized. This antenna roll-off was measured to be 3.6 dB at low elevation and 6.5 dB at high elevation angles. Techniques for improving the antenna's performance include a deformable mirror and an array feed. The deformable flat plate, which is inserted in the optical ray path of the antenna, compensates for the gravity distortion of the antenna main surface by phase conjugate deformation, thus restoring the focal point of the antenna. The Array Feed Compensation System (AFCS) utilizes signal combining and tracking from a seven element array feed. It combines the distributed energy in the focal plane of the antenna due to a gravity induced defocusing, and also provides for closed loop tracking. The AFCS combines the two functions of gravity distortion compensation and closed loop tracking into one system. The DFP combined with a monopulse tracking system also provides the same two functions. A theoretical and experimental study compared the deformable flat plate (DFP) and an array feed compensation system (AFCS) performances on the DSS-14 70-meter antenna at Ka-Band (32-GHz).

In addition to adding Ka-band, it is necessary to maintain the existing transmit and receive functions at S- and X-band. This paper shows how the results of the study led to the currently proposed system for adding Ka-band to the existing 70-meter antenna.